635.55
423.8

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

FOREST INSECT DATA

M.C. PLOTS 9, 10 and 11, STANISLAUS NATIONAL FOREST

SEASON OF 1929

by

J. M. MILLER
Senior Entomologist
U.S. Bureau of Entomology

Stanford University, California
April 25, 1930

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FOREST INSECT DATA
M.C. PLOTS 9, 10 and 11, STANISLAUS NATIONAL FOREST
SEASON OF 1929

FOREST INSECT SURVEY

The forest insect phases of this mill scale study consisted of:

1. A cruise of all three plots to determine the volume of recent losses due to insects. This survey was made by J.M. Miller June 5 and 6, 1929. All trees which were considered to have been killed by insects during the three preceding seasons were marked and recorded under an insect survey number. If the dead tree had been previously numbered in the forest inventory of the plot, this number was entered on the insect record; if not previously numbered, the number of the nearest plot-inventory tree was taken.

2. Examination of a selected series of trees after felling to secure a stem analysis of the type of insect attacks connected with the top-killing and dying of white fir. Records were secured from a series of 60 trees. This examination was carried out by E.D. Edmonston and J.M. Miller during the period from June 21 to July 14, 1929.

A list of trees marked as insect-killed is attached to this report. The losses representing merchantable volume can be summarized by seasons as follows:

White Fir (killed mainly by Scolytus ventralis)

Year of Attack	Number Trees	Volume Board Feet	
1926	4	5,250	
1927	7	10,110	(1 tr. 130 bd.ft.topk.1926)
1928	30	34,050	(12 " 20,170 " 1927)
Total	41	49,420	

Sugar Pine (killed by Dendroctonus monticolae)

1925	11	3,700
1926	1	11,800
1928	6	890
	18	15,490

Yellow Pine (killed by Dendroctonus monticolae)

1928	1	690

In addition, the following dead poles below merchantable size were recorded:

White fir (killed by Scolytus ventralis)

Year of Attack	D.B.H. 2"	4"	6"	8"	Total
1926				2	2
1927			1	6	7
1928	1	4	1	4	10

CLASSES OF INSECT DAMAGE IN WHITE FIR

The type of losses in this host tree is difficult to appraise, as a very large percentage of the trees on the area have been top-killed or partially killed only. The 41 trees listed in the cruise were killed down practically to base, so that there was no possibility of their continuing to live as top-killed trees. This group of trees therefore represented a tangible loss which could be easily measured. In this group 12 trees were noted as previously top-killed, so that the process of dying had extended through two and in some cases three seasons.

Altogether an examination and stem analysis was made of 15 of the 1928-killed trees after they had been felled.

In addition to the trees marked and numbered as insect-killed, some were noted as top-killed. In these trees a certain amount of injury due to insects had occurred, although the trees were still alive and many of them were making perceptible increment. Trees in this class, therefore, could not be classified as a tangible loss, and the extent of the top-killing injury, varying greatly in different trees, is therefore difficult to estimate on a volume basis.

In grouping trees according to type and extent of insect injury it is possible to recognize four classes, which are illustrated in Photos 1 and 2.

Class I Recent top-killed. Approximately 25 per cent or less of crown killed, balance of trunk and foliage normal; deadened area does not extend much below thin-bark area of upper bole.

Class II Old top-killed, recovering. New leader formed to replace old one, which is usually rotten and broken.

Class III Dying top-killed. Over 50 per cent of bole and crown dead; few lower limbs and lower bole green.

Class IV Dead. Entire crown dead; cambium dead or infested approximately to base of bole.

Insects Causing Injury and Character of Attack

Class I. Recent top-killing was found to be due almost entirely to the fir engraver beetle, Scolytus ventralis Lec., attacking under the thin bark in the upper bole. The egg galleries of a smaller fir engraver, Scolytus praeceps Lec., occasionally appeared in the extreme top, usually above 3' diameter. This latter species is considered to be entirely secondary. An examination and stem analysis was made of 24 felled trees, which were grouped in this class. Of these 21 showed distinctly the work of Scolytus; in the other three trees there was no evidence of insect attack, but all three were heavily infested with mistletoe. The following is a list of plot numbers of trees examined after felling: C-5,22,24,44,73,148,149,162,194,314,415,471,491,551,560,620, 633,698,767,995,997,1002,1144,1250.

Class II. Trees of this class are common in the Sierra white fir type. The original top has usually been dead for at least ten years and in some cases the killing of the leader can be dated back for from 75 to 100 years. In Tree C-28 the top was killed in 1834 and was followed by very suppressed growth rate up to the present time. On some trees two, three and even four new leaders grew up to replace the original top. These new leaders may in turn be killed back by insects, some trees being found where the tree had put out several successive leaders in the attempt to replace the original top.

Of 11 trees of this group which were examined after felling, all showed healed-over scars of Scolytus ventralis attacks around the base, where the original leader was killed. On seven of these trees recent attacks of Scolytus were found on the newly-formed leaders. The following are plot numbers of felled trees from which a stem analysis of the infestation was made: C-28,79,80,82,632,634,675,781,793,795,1405.

Class III. The trees included in this group were green at the base, and no evidence of insect attack could be found in the lower 8' of the trunk. However, the trees had died down to the point where there was little prospect of their recovery. These trees were not marked as insect-killed, as the nature of the infestation could not be determined from an examination of the cambium near the base. After felling, however, it was found that Scolytus ventralis was responsible for killing the cambium area under the thin bark in the upper part of the tree, and that a combination of attacks by Scolytus and a Cerambycid borer, Tetropium abietis Fall, had killed the cambium under the thicker bark on the lower bole. In practically all the larger trees killing of the thin-barked area of the upper bole preceded by one or two seasons the attack under the thick bark of the lower bole. The dying-down process of the larger trees therefore represents successive attacks of several seasons, with considerable primary attack of the Cerambycid in the lower bole. The following are the plot numbers of trees in this group which were examined after felling: C-52,55,56,135,608,618,792.

Class IV. The larger trees in this group represent the next stage of attack after the condition found in Class III. The lower base was infested mainly by Tetropium abietis, and the upper part of the bole infested or abandoned by Scolytus ventralis and Tetropium, depending upon the period that attacks had been in progress. In the smaller trees Scolytus extends the attack down to the base, where its galleries may be in mixture with Tetropium under the thick bark. In trees under 10" d.b.h., Tetropium may not occur at all, although the work of secondary cerambycids (Monochamus) may be associated with Scolytus. The work of flatheads (Chrysobothris and Melanophila) is also common in trees of this group, but the character of the attack is secondary to that of the species already mentioned. This group is represented by the 41 white fir trees marked in the preliminary cruise of the plots. The following are the felled trees from which was secured an analysis of the infestation according to bark surface: I (insect no.) 34,40,50a,51,52; C-54, 81,143,150,233,607,701,998,1001,1062.

INSECT DAMAGE IN SUGAR PINE

The insect damage to this species was second in importance to that in white fir. Losses were largely due to the mountain pine beetle, Dendroctonus monticolae. A group of 11 trees was killed about 1925. A large tree was killed in 1926 which showed evidence of the attack of D. monticolae and a flatheaded borer, Melanophila gentilis Lec. No losses occurred on the plots in 1927. In 1928 6 small trees were killed by D. monticolae. Owing to the small acreage included in these plots, they do not reflect the general cycle of bark beetle infestation in the general region.

INSECT DAMAGE IN YELLOW PINE

Only one tree killed by insects was found on the plots. This tree (C-739, 26" d.b.h.) was killed by D. monticolae in 1928. The plots are above the zone of western pine beetle infestation and no evidence, either old or recent, of this beetle was found.

DISCUSSION

Scolytus ventralis Lec.

On the basis of the survey and further studies of these plots, the fir engraver stands out as by far the most important forest insect to be considered in this forest type. The life history of the species has not been definitely determined. It apparently has an annual generation, the new beetles from overwintering trees emerging and attacking new trees late in June and early in July. Some records from Abies magnifica indicate that it may require two seasons for some broods to complete development; but in white fir at lower elevations an annual generation is to be expected.

Nature of Attack

When the adult enters the live inner bark and cuts an egg tunnel transversely across the surface of the sapwood, the cambium dies rapidly both above and below the scar made by the beetle. There appears to be some toxic effect associated with the attack which is not found with other species of cambium-feeding insects (see Photo No. 3). It is in this deadened area that the larval mines develop and subsequent pupation takes place. The beetles are readily trapped to the thick bark of down logs, but in standing trees there is an apparent preference for attack in the thin, smooth bark of the upper part of the tree. It will attack, however, under the thick bark of standing trees which have been previously top-killed, but usually in association with the Cerambycid, Tetropium abietis Fall.

The ability of this beetle to deaden a limited area of cambium gives it an advantage over most other species of bark beetles. It can successfully attack and rear a brood in a live tree, regardless of whether or not the tree is killed by a concentration of other adults so as to complete the girdling of the trunk. For this reason many living trees have been attacked by scattering egg galleries without showing any of the symptoms of dead top or dying limbs. The broods develop in the deadened patches of cambium and emerge. Unless heavily reattacked the next year the tree continues growth. Evidence of attacks of this character on live trees was found on the plots after the trees were felled, although it was impossible to recognize them while the trees were standing.

Not all attacks on standing living trees are successful, in that occasionally the killing of a cambium area large enough for brood development is not accomplished. The scars of attacks on trees not killed heal very rapidly and are soon imbedded in the new growth which covers them. One characteristic of these attacks is the brown discoloration of the surface of the sapwood, which extends for a considerable distance above and below the groove cut by the egg gallery. After the attacks are healed the annual ring of the year in which attack occurred retains the characteristic discoloration and can often be traced for several feet above and below the scar (see Photo No. 4).

Where attacks are so heavy as to cause top-killing, a perceptible slowing-down of growth results (see Charts 1 and 2). However, in dating back old attacks which did not result in heavy top-killing, there does not appear to be any consistent relation to slowing-down of the growth rate either before or after the year of attack (Chart 3).

Selection of Trees

No definite selection of trees, whether fast- or slow-growing, young, mature or overmature, can be established from the records secured so far in this study. The attacks of Scolytus appear to be more or less indiscriminate in the top-killing of mature trees and the entire killing of young trees. However, once a tree has been completely top-killed it seems to show some susceptibility to further attacks, or at least is more likely to attract the beetles than trees which are not top-killed. However, this tendency may be due also to the attraction of Tetropium, which is also attracted to and nearly always associated with Scolytus in the killing of the basal sections of trees. However, a great many Type II trees on this area have survived the original top-killing, which indicates that there is no consistent selection of such trees in subsequent attacks.

Relation to Mistletoe Infection

Apparently there is no definite selection by Scolytus of trees infected by the broadleaf mistletoe (Phoradendron). Several trees in which heavy mistletoe infection appeared to be choking the top were examined after falling, but no evidence of Scolytus attack was found. Only a few of the Scolytus-attacked trees contained more than a mild mistletoe infection. The evidence seems to indicate that trees suffering from heavy mistletoe infection are avoided by Scolytus.

Possibility of Damage to Second Growth

Young, thrifty trees under 12" d.b.h. are usually killed entirely as a result of one season's attack of Scolytus. This insect will probably be a serious pest to the second-growth stands of white fir on cutover areas, not only because of the killing of younger trees, but also because of the top-killing of larger trees, producing an injury which gives access to wood-destroying fungi.

Tetropium abietis Fall

The eggs of this cerambycid are laid on the outer bark; the larva enters the cambium as a tiny grub and proceeds to make a winding, irregular mine which increases in width with the growth of the larva. While trees in a weakened condition are selected, attacks are common in trees which still maintain a perceptible growth rate. Healing over of the scars made by larval mines usually occurs until the resistance of the tree is broken down by the concentration of Scolytus and Tetropium attacks (see Photo No. 5). However, some trees recover entirely after the initial attacks, and scars made by Tetropium will be found imbedded in the wood.

While this insect is undoubtedly primary at times, it shows no tendency to become epidemic and kill trees to any extent unless associated with initial injuries due to Scolytus or other causes.

LIST OF INSECT-KILLED TREES
MARKED ON METHODS-OF-CUTTING PLOTS 9, 10 AND 11,
PICKERING TIMBER SALE, STANISLAUS, CRUISE JUNE 5 & 6, 1929,
BY J. M. MILLER

White Fir - Trees Killed Season of 1926

Tree No.	Location by M.C.Plot No	Estimated DBH	Logs	Vol.	Basal Exam. Year Att.	Primary Insects	Insects Noted After Felling
7	Next to C-1320	34"	5	1,650	1926	Scolytus ventralis	*
33	10' N. L-78	18"	2	150	1926	S.v., T.abietis	*
38	20' S. L-137	16"	4	280	1926	0	*
50	20' NE C-605	40"	8	3,280	1926	Tetropium abietis	*
		Total		5,260			

White Fir - Trees Killed 1927; Top-killed 1926

39	25' W C-1010	14"	2	130	1926 -27	S.v., T.a.	*
		Total		130			

White Fir - Trees Killed 1927

8	Next to C-1322	28"	4	700	1927	T.a., Pla-typus sp.,	*
11	L-1636	50"	8	5,580	1927	T.a., ler-vae, Ambr. work	*
17	25' NE L-217	12"	2	110	1927	S.v., T.a.	*
21	30' SE L-283	44"	6	3,390	1927	T.a. ler-vae, Amb. lit.work	*
25	C-54	22"	3	340	1927	Mel.work, Ambrosia	Base to 33' S.v.&T.a.larv. 33'-top dead;old S.v. att. 1927
27	20' S C-625	10"	1	40	1927	T.a.	*
		Total		9,990			

*No examination after tree was felled

White Fir - Trees Killed 1928; Top-killed 1927

Tree No.	Location by M.C.Plot No	Estimated DBH	Logs	Vol.	Basal Examination Year	Primary Insects	Insects Noted After Felling
					1927		S.v. 1927 att.abv.32'
2	C-607	32"	6	1,620	1928	T.a. larvae	T.a.'28 att.base to 32'
					1927	T.a.larv. em.	
5	30' SW C-329	23"	3	580	1928	Bel. work	"
					1927		
6	Next to L-930	43"	7	4,530	1928	T.a.emerging	"
					1927	Green; fresh	
9	L-1296	26"	4	680	1928	Ambrosia work	"
					1927	T.a. larvae,	
10	Next to L-930	34"	7	3,180	1928	Ambrosia work	"
					1927	S.v. unsuccess	
16	L-818	24"	4	580	1928	ful attack	"
					1927	T.a. larvae,	
19	20' W C-1590	56"	8	7,070	1928	Ambrosia work	"
					1927	T.a.,Melan.,	Base-12' T.a.; 1½-1;
26	C-143	20"	5	500	1928	Amb. beetles	Platypus work; 12-48', T.a., S.v.; 48-77', S. v. and Cerambycids
					1927	S.v. unsuc.	
29	50' W C-964	26"	5	870	1928	att.; Amb.	"
					1927		
30	10' S L-144	28"	5	1,010	1928	T.a.	"
					1927		Sv att.1927 upp.bole
35	C-998	16"	4	280	1928	S.v., T.a.	Base to 25' lar.½-⅔"; 25-46' l. and p.
					1927	S.v. full-gr.	Base-74' S.v.larvae;
40	10' SE C-1011	18"	4	330	1928	larvae	44'-top S.v.1927 att. T.a.
		Total		20,170			

White Fir - Trees Killed 1928

Tree No.	Location by M.C Plot No.	Estimated DBH	Logs	Vol.	Basal Examination: Year Att.	Primary Insects	Insects Noted After Felling
1	10' E C-592	16"	5	620	1928	T.a. larvae	"
4	C-618	44"	6	2,970	1928	Crown red	Green upp.40' Base-32' green; 32-75' S.v. ½-1 larv.; 75-90' Ityophthorus sp.
15	L-263	18"	3	240	1928	Ambr. work; cambium green	S.v., probably primary
20	C-228	20"	3	290	1928	Green	" "
22	C-52	26"	4	680	1928	"	Base-18' green; 18-60', S.v.& T.a.lar.; 60-75' top dead, killed about 1901 by S.v.(old S.v. 1901-05 near top)
24	C-55	26"	3	490	1928	Mel., Ambrosia beetle	Base-12', T.a.work; 12-48', T.a., S.v., l.p. (S.v.1927 att.unsucc.)
25	C-61	20"	4	400	1928	Green	Base-9' S.v. ½-¾ lar.; 9-26' S.v.& Temnochila virescens; 26-89' S.v. p,Ad., few Ceramb.; 89-96' Scolytus praeceps
28	C-150	16"	3	210	1928	T.a.	Base-26' S.v.lar.full-gr.; T.a. l.p.a.; 26-54' S.v.& Rhagium; 54-75' top S.v. and S.p.
31	C-982	32"	4	1,090	1928	T.a.	"
32	C-1062	30"	6	1,420	1928	Cambium green	Base-21' Ceramb., F.H. larv. ½ gr.; 21-50' Cer. & Asemum; 51-92' S.v. work
34	10' S. L-121	20"	4	400	1928	S.v. full-grown larvae	"
36	C-1001	26"	4	680	1928	T.a. larvae	Base-62' light S.v.att. T.a.work, lar. ½-1; 62-90' T.a.work abundant
37	20' N. C-1059	14"	3	180	1928	Melanophila	"
41	Next to L-252	10"	1	40	1928	S.v. full-grown larvae	"
42	30' S. L-252	40"	8	2,600	1928	T.a. ½-gr.lar.	"
43	C-910	26"	5	870	1928	Green at base: S.v. above	"
44	C-791	18"	3	240	1928	Green at base: S.v. above	"
46	L-960	22"	4	480	1928	T.a.lg.larvae	S.v. probably primary
		Total	13,880				

Sugar Pine - Trees Killed 1926

Tree No.	Location by W.C. Plot No.	Estimated DBH	Logs	Vol.	Basal Examination Year Att.	Primary Insects	Insects Noted After Felling
19	50' SE C-379	68"	9	11,150	1926	D. melanophila, D. monticolae	*

Sugar Pine (group) - Trees Killed 1925 or 1926

	Near A-585	20"	3	500	25-6	D. monticolae	*
	"	18"	5	370	"	"	*
	"	18"	4	130	"	"	*
	"	8"	2	40	"	"	*
	"	19"	4	300	"	"	*
	"	14"	3	170	"	"	*
	"	14"	3	170	"	"	*
	"	20"	5	500	"	"	*
	"	28"	6	1,100	"	"	*
	"	16"	4	270	"	"	*
	"	12"	3	150	"	"	*
		Total		3,700			

Sugar Pine - Trees Killed 1928

12	20' SW L-234	8"	1	30	1928 W	D.m. new ads.	*
13	20' SW L-234	8"	1	30	1928 W	" "	*
14	20' SW L-234	8"	1	30	1928 W	" "	*
45	30' SE L-239	10"	1	40	1928 S	D.m.abandoned	*
47	15' NE L-964	10"	2	80	1928 W	D.m. larvae	*
49	30' S L-999	10"	2	80	1928 S	D.m.abandoned	*
		Total -		290			

Yellow Pine - Trees Killed 1928

48	C-788	26"	3	500	1928	Green at base Ambrosia work	D.m. infestation from 8-59' on bole--new ads.

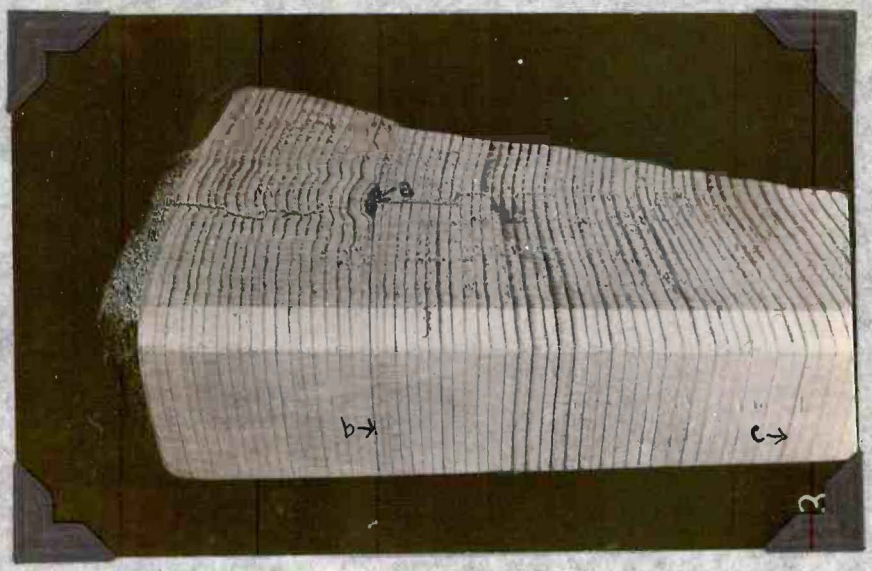


Photo No. 1 (7325). Classes of injury to white fir by Scolytus ventralis Lec. and Tetropium abietis Fall, showing phases of top-killed, dying and dead trees.

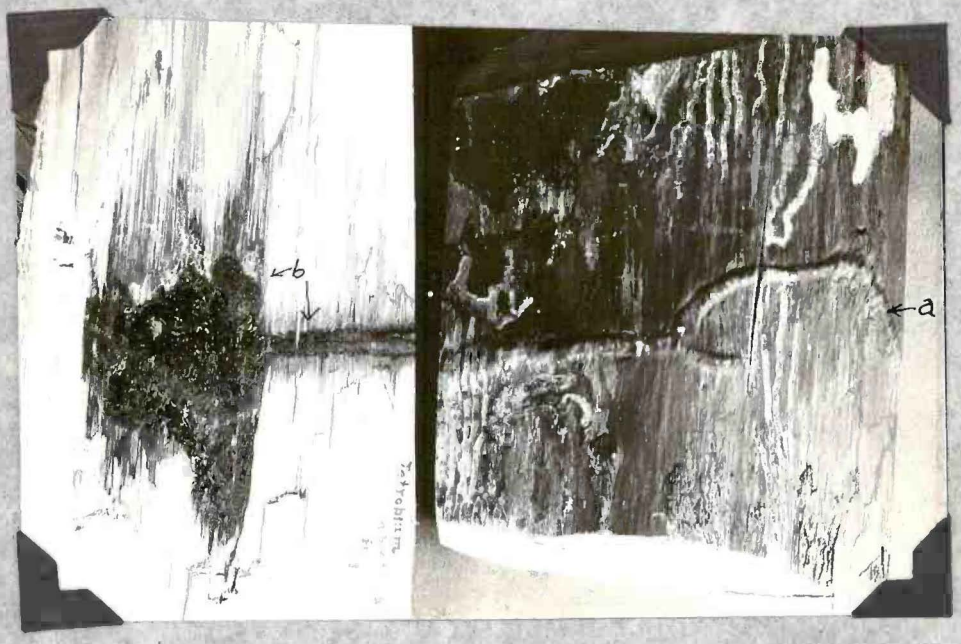


Photo No. 2 (7325). Diagram of bark surface area, showing distribution of infestation in top-killed, dying and dead white fir.

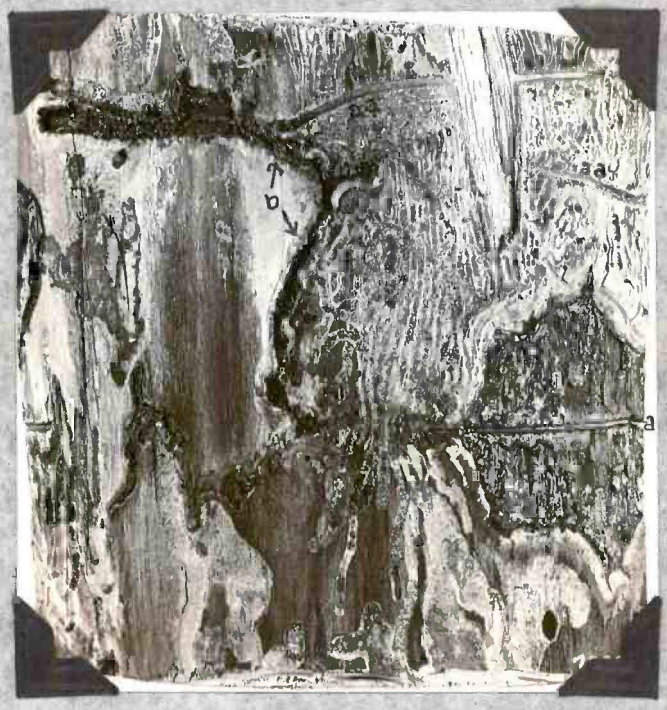


Photo No. 3 (7329). Partially healed scars caused by Scolytus ventralis and Tetropium abietis in white fir.

a. Egg gallery of Scolytus ventralis cut in live cambium two years before tree was killed; this shows the deadened area extending above and below egg gallery and the new wood which has partially healed over the margin of this scar.

aa. Egg galleries and larval mines of Scolytus on surface of sapwood which resulted in killing of tree.

b. Larval mines of Tetropium abietis cut in live cambium one year before tree was killed; this is partially healed. Note that no deadening of cambium extends beyond the initial mine, as in the case of Scolytus (a).

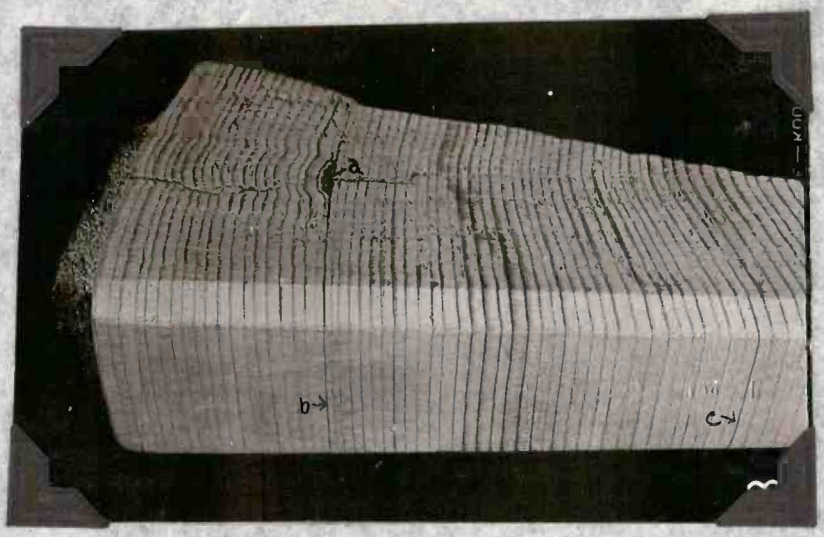


Photo No. 4 (7323). Section from white fir showing discoloration of annual rings following attack by Scolytus ventralis.

a. Part of healed scar made by attack during season of 1909
b. Discolored ring extending above and below the 1909 attack
c. " " " from scars of an attack made in 1876

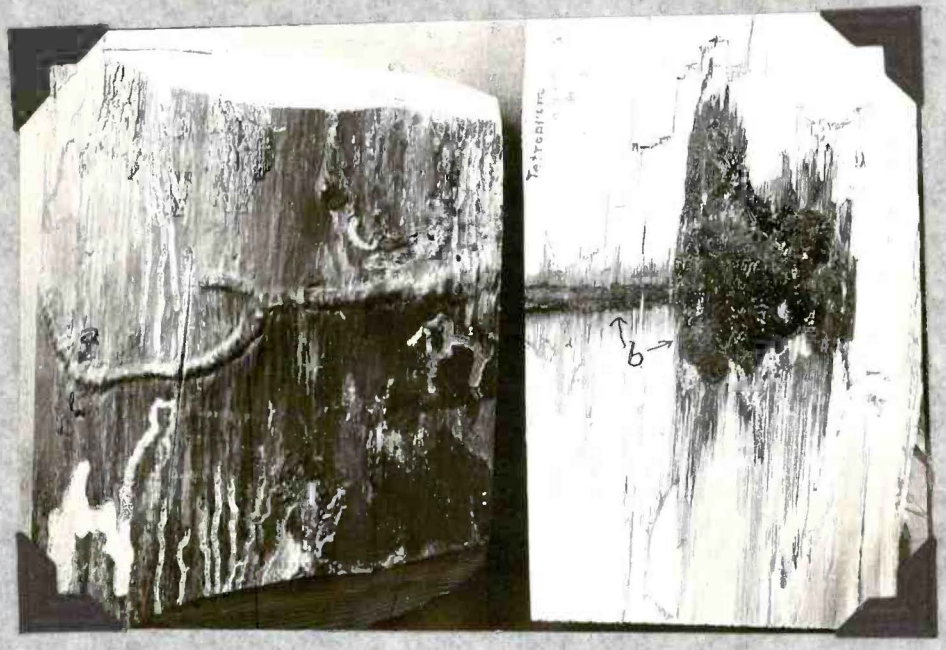
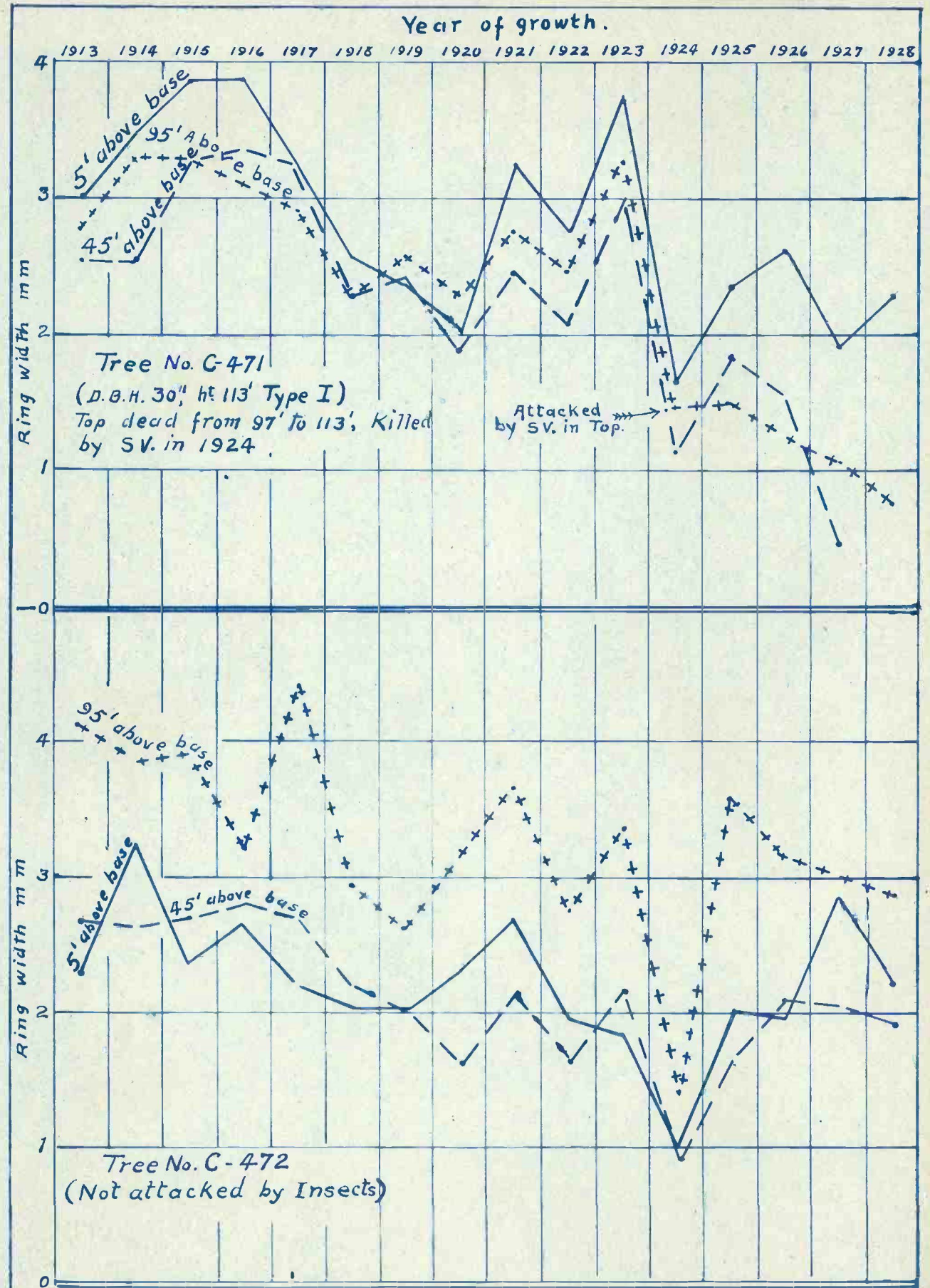


Photo No. 5 (7322). Scars made by larval mines of Tetropium abietis in living white fir.

a. Part of larval mine imbedded in sapwood
b. Outer surface of sapwood, showing ridge caused by healing over of larval mine cut in live cambium three years before tree was killed. Unhealed scars of larval mines of Scolytus and Tetropium made when tree was killed also show on surface of this section.


Year of growth.
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928
Ring width mm
5' above base
95' Above base
45' above base
Tree No. C-471
(D.B.H. 30", ht 113' Type I)
Top dead from 97' to 113', Killed by SV. in 1924.
Attacked by SV. in Top.
95' above base
5' above base
45' above base
Tree No. C-472
(Not attacked by Insects)

Insect Studies-(M-C Plots, 9, 10 and 11. Stanislaus, N.F. Diagram of Growth rate of Top-Killed White Fir (Type I) and check Tree of similar diameter and height on the same site.

Chart No. 1

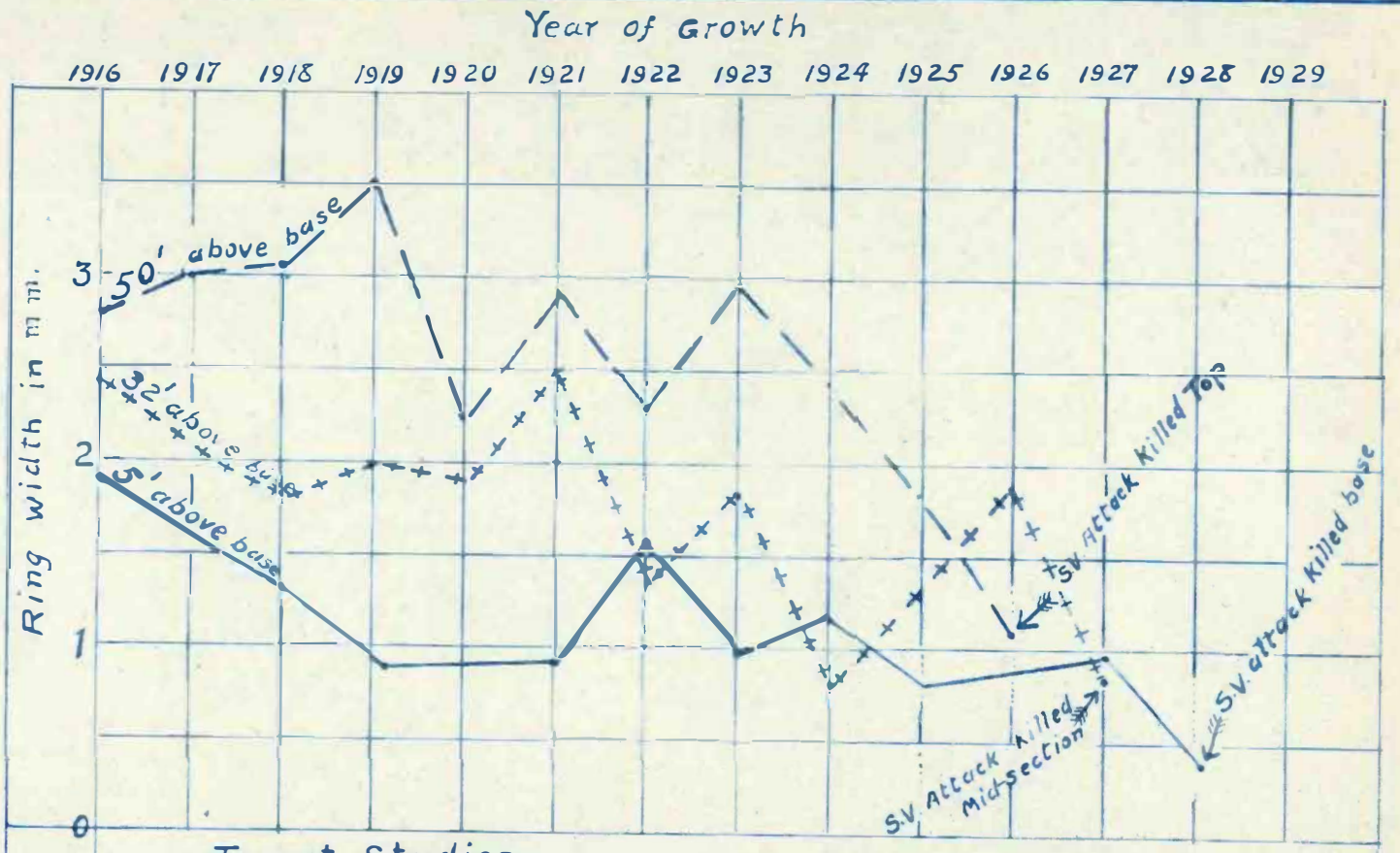
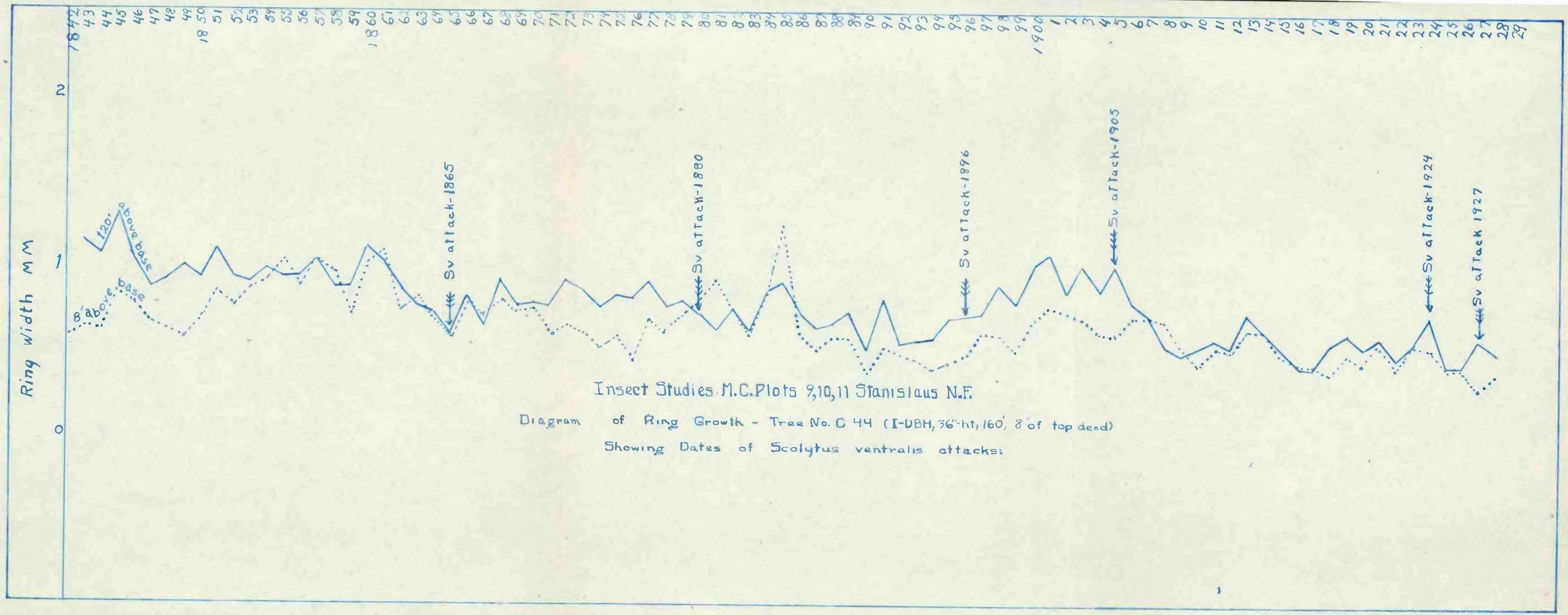


Chart No. 2

Insect Studies –

M.C. Plots 9, 10 and 11, Stanislaus N.F.

Tree No. C 150 (D.B.H. 16" ht 75 t. Type IV) Diagram of growth rate at base mid-section and top and year of attack by Scolytus ventralis.



Insect Studies M.C. Plots 9,10,11 Stanislaus N.F.

Diagram of Ring Growth - Tree No. C 44 (I-DBH, 36"-ht, 160', 8' of top dead)

Showing Dates of Scolytus ventralis attacks:

Chart No. 3